Smell Behavior During Odor Preference Decision

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Smell behavior during odor preference decision

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Abstract

The present study investigated the orienting behaviors in perception of odors during a preference-based decision making task. The focus of our study was on smell duration, especially during the first exposure. Participants were instructed to choose the most preferred odor among multiple alternatives. The alternatives in Experiment 1, 2 and 3 were manipulated so that the similarity among alternatives became higher; in Experiment 1, the alternatives were chosen from multiple categories (e.g., laundry detergents, beverages), in Experiment 2 they were from a single category (six kinds of flavored tea), and in Experiment 3, they were from a single subcategory (six kinds of jasmine tea). Results showed that the chosen odor was smelled longer than non-chosen odors (the smell bias effect) during the first exposure. However, this effect only occurred when alternatives consisted of different categories. Furthermore, the smell bias effect did not occur when participants chose the most intense odor. These results suggest that orienting behavior reflected participants' preference only when the odors were relatively easy to discriminate from each other.

Introduction

The process of making choices, as well as the influential factors on choice-making, has been the focus of many decision-making studies in both cognitive and social psychology, and has been frequently investigated using the multi-alternatives forced choice (m-AFC) paradigm. Although previous studies have mainly used visual stimuli (e.g., pictures, abstract figures) as alternatives, we often make choices based on smell in our daily life (e.g., when we buy food or toiletry products). Therefore, studies considering olfactory properties are necessary. When people try to identify familiar odors without a linguistic or visual cue, the percentage of correct identification is about 50% (Cain 1979). Such difficulty of odor identification has been shown in several other studies (Engen 1987; Cain et al. 1998; Jonsson et al. 2005), and this is one of the sensory characteristics demonstrated in olfaction. On the other hand, when odors are provided with linguistic labels, the pleasantness of the odor becomes influenced by the meaning of the label (Dalton 1996; de Araujo et al. 2005). Moreover, pleasantness rating of an odor might be influenced by the sequence of evaluation (e.g., Zellner et al. 2003). Although there have been many studies investigating the influence of a single odor on hedonic evaluation, the effect of comparison between and of selection from multiple odor samples on hedonic evaluation within the same tasks (e.g., an m-AFC paradigm) has not been examined in detail.

Several studies have focused on the orienting behavior in the perception of visually presented alternatives. Shimojo et al. (2003) investigated the relationship between preference decision-making task and gaze behavior using pairs of human faces and pairs of abstract figures. Observers' gaze gradually shifted toward the stimulus that they ultimately chose before they made their decision (gaze cascade effect). Shimojo et al. interpreted this effect as a combination of preferential looking (Birch et al. 1985) and mere exposure effect (Kunst-Wilson and Zajonc 1980; Zajonc 1968). However, Nittono and Wada (2009) replicated Shimojo et al. (2003) study reported that gaze cascade effect occurred not only in preference decision, but also in decisions based on objective characteristic of stimuli (brightness of abstract figures); thus it remains unclear the extent to which orienting behavior is linked to preference. Studies which focused on the dwell duration have indicated that a bias in dwell duration toward the chosen stimulus can be seen in the observers' first exposure to each stimulus that is encoding phase, in which qualitative features of each alternative is encoded for comparison (Glaholt and Reingold 2009). Although the dwell bias appears to be caused by preferential looking when people choose items that they most prefer (Schotter et al. 2010), it remains unclear whether this phenomenon occurs especially in the case of preference decision.

While the above-mentioned studies focus on the aspects of perceptual processes of alternative stimuli during a choice task, others have looked at the influence of thinking styles of decisions (deliberative or intuitive) on choice behavior. Previous studies revealed that deliberative decisions (i.e., analyzing the reasons for choice or paying attention to a variety of attributes of the stimuli) reduces post-choice satisfaction (Wilson et al. 1993), and disrupts consistency of preference and accuracy of decision (Nordgren and Dijksterhuis 2009). Thus, deliberative decision-making appears to cause people to focus on accessible attributes of stimuli, resulting in changes to their attitude.

The aim of this study was to investigate the orienting behaviors in perception for odors when participants choose the most preferred odor among multiple alternatives. Participants compared alternatives in order to decide which was the most suitable in accordance with the goal of the task (in this case, preference decision). Critically, the more similar each of alternatives is to each other, the more difficult decision making is, and therefore choice behaviors also might be influenced by the alternatives. To investigate the influence of the similarity among odor alternatives on behavior, we also manipulated the categories of alternatives. In Experiment 1, the alternatives were chosen from a variety of odor materials that included both food-related and unrelated odors that are common, pleasant odors from everyday life. Hence, the set of odor alternatives, in Experiment 1, came from “multiple categories”. In Experiment 2, the odor alternatives (apple, peach, jasmine, etc.) from a “single category” (i.e., flavored tea) were used. Finally, in Experiment 3, the alternatives were chosen from a “single subcategory” of a category used in Experiment 2 (i.e., different types of jasmine tea odors).

Thus, alternatives became more and more similar to each other from Experiment 1 (multiple categories), to Experiment 2 (single category), to Experiment 3 (single subcategory). In other words, the similarity of qualitative odor characteristics was manipulated by changing the broadness of the category between experiments. In all of the experiments, three behavioral indices during choice making were compared between the chosen odor and the non-chosen odors. To investigate the relationship between orienting behavior and preference decision (Glaholt and Reingold 2009; Nittono and Wada 2010; Schotter et al. 2010; Shimojo et al. 2003), we measured 1) smell duration time at first exposure and total smell duration for the chosen odor and the non-chosen odors. In addition, we also analyzed 2) total decision-making time and 3) choice behavior patterns, to examine whether choice behavior changes with decision styles. Furthermore, Experiment 2 was conducted to confirm whether these behavioral characteristics were indeed associated with making a decision based on preference, or would be influenced by other types of judgments. To this end, we assigned each participant to either a preference-decision group, in which the task was to select the most preferred odor, or a control (odor-intensity) group, in which the task was to simply select the most intense odor. In Experiment 3, participants were provided with the alternative category beforehand. This was done to investigate the influence of knowledge on the alternatives on choice behaviors.

Experiment 1

In this experiment, we conducted a 7-AFC task based on preference decision. Alternatives were from multiple categories.

Methods

Participants

Thirty-four undergraduate and graduate students from the University of Tsukuba (22 females and 12 males, mean age 22.7 years) participated in this experiment. All participants were healthy with no self-reported problems in their sense of smell. They were individually tested. This study was approved by the Human Research Ethics Committee of the University of Tsukuba. All participants were informed about the task and gave written informed consent to participate.

Stimuli

In order to determine the types of stimuli for this experiment to reflect common odors from everyday life, we first conducted a pilot study on a separate group of undergraduate students. In a questionnaire survey, we asked 34 participants (28 females and 6 males, mean age

20.8 years) about their favorite odors in their daily lives, by using a free-description method. The seven most commonly reported odors from this pilot study were selected for use in this experiment (Table 1). These odor stimuli were put into opaque polypropylene bottles. The intensity of each odor was judged by experimenters to be relatively equal to each other.

Procedure

Seven odor-containing bottles were placed in random order in a line on a table before each experiment. First, participants were asked to freely smell each of the seven odors arranged in a line in front of them and to choose the odor they most preferred among them. The order of smelling seven odors was randomized for each participant. Participants were given unlimited time to make their choice, and were unrestrained for the number of times that they could smell each bottle. Furthermore, they were allowed to move the position of each bottle if they wanted to. In addition, participants were not told the names of any of the odors. Up until the participants made a decision, their behaviors were recorded by a video camera.

Data analysis

Smell duration time and choice behavior patterns (see below) were first defined by the experimenter and two other raters (the agreement between experimenter and two raters were good; Cohen's *kappa* = .64, .65). Each behavioral index was measured from the video footage based on these definitions. Smell duration was calculated from the point which the participant brought the bottle close to their nose until the point when they began to move the bottle away from their nose. The total smell duration, collapsed across all of the number of times an odor was smelled, was calculated for each odor. The first time that the participant smelled each odor was defined as the first smell. Duration time for the first smell was also calculated for each odor. Smell durations were standardized with z-scores for each participant in order to avoid the influence of individual differences in the time spent on decision-making. Thus, from this point forward, "smell duration" will represent the standardized value. The smell duration of the chosen odor (i.e., most preferred) was compared to the average of the smell duration of the non-chosen odors (i.e., the other six odors). Comparison between the chosen odor and the non-chosen odors was conducted for the total and for the first smell duration separately.

Choice behavior of participants was classified into three patterns based on their behavior after they had smelled each of the alternatives once. Participants in the "Immediate type" smelled each odor just once. Participants in the "Narrowing-down type" smelled all of the odors first and then made a decision after smelling only a few of the odors again. Participants in "Indecision type" smelled all of the odors first and then smelled more than four of the odors repeatedly before making a decision.

Results and Discussion

Mean decision time was 2 m 7 s (range: 49 s to 3 m 47 s) as shown in Table 2. Total smell duration time did not differ between the chosen odor and the non-chosen odors [t (33) = 1.04, p = .31]. For the first exposure, however, smell duration for the chosen odor was longer than that for the non-chosen odors [t (33) = 2.29, p < .05], indicating that the smell bias effect had occurred (Fig. 1). These results were similar to the findings of the visual study where dwell duration toward the chosen stimulus was longer for the observers' first exposure to each stimulus (Glaholt and Reingold 2010). Thus, it is possible that there is a relationship between orienting behavior and preference decision in olfaction as well. There were no sex differences in decision time or in smell duration. In terms of the choice behavior of participants (Table 2), there was no difference among three choice behavior patterns on the first smell duration for the chosen odor. Most participants (53%) were assigned to "Indecision type" in this experiment. A one-way ANOVA with the behavior pattern (Indecision vs. Narrowing-down vs. Immediate) as the factor and the decision time as the dependent variable revealed a significant main effect [F (2, 32) = 13.39, p < .01]. Decision times were significantly longer in the order of "Immediate type" (M = 2 m 29 s), "Narrowing-down type" (M = 1 m 55 s), and "Indecision type" (M = 1 m 9 s; Holm multiple comparison test ps < .05). Overall, most participants tended to spend a long time in making their decision.

Experiment 2

In this experiment, we confirmed the occurrence of a smell bias effect by using six kinds of odors from a single category (i.e., flavored tea leaves). In addition, we set up the intensity decision group, where participants were required to choose the most intense odor among the alternatives, to investigate whether the smell bias effect occurs not only with preference, but also with other types of judgments.

Methods

Participants

Forty-three undergraduate and graduate students from the University of Tsukuba (34 females and 9 males mean age 22.8 years) participated. None of them reported problems in their sense of smell. None of the participants recruited for this experiment had participated in Experiment 1. Participants were randomly assigned to either the preference-decision group (19 females and 4 males) or the intensity decision group (15 females, 5 males).

Stimuli

Alternatives were chosen from a single category: flavored tea. The six flavored tea leaves were used as odor stimuli (Table 1). Each odor stimuli was put into opaque polypropylene bottles. In a pilot study, five undergraduate students (4 females), who did not participate in the main experiment, rated intensity (0: unscented to 6: strong) and pleasantness (1: very unpleasant to 7: very pleasant) of each of the six odors on a 60mm Visual Analogue Scale (VAS). Mean intensity was 3.20 (SD = 0.43) and pleasantness was 4.50 (SD = 1.46). There were significant or marginally-significant main effects [intensity: F (5, 20) = 2.38, P < .10; pleasantness: F (5, 20) = 3.48, P < .05], although pairwise comparisons did not show any significant differences among odors.

Procedure

In the preference-decision group, the procedure was the same as in Experiment 1. In the intensity decision group, the procedure was also the same except that participants were required to choose the most intense odor among six alternatives. Participants were recorded with a video camera until their decisions were made. After they made their decisions, participants in both decision groups rated the pleasantness of each of six odors on the 60mm VAS from 1 (very unpleasant) to 7 (very pleasant).

Results and Discussion

Mean decision times were 2 m 20 s (range: 47 s to 5 m 26 s), 2 m 47 s (range: 1 m 5 s to 5 m 44s), in the preference and the intensity decision group respectively (Table 2). Participants in the intensity decision group tended to spend more time for decision making than those in the preference decision group, but the difference between groups was not significance [t (41) = -1.06, p = .30; Cohen's d = 0.32]. There were no significant main effects and interactions for either the first or total smell duration time in the both groups, $Fs \leqq 1$ (Fig. 1). As in Experiment 1, there were no sex differences in the decision time and smell duration for this experiment. Since the difference between the alternatives was smaller than Experiment 1, it appeared that distinguishing the qualitative features of odors was more difficult for the participants in Experiment 2. We examined the smell bias effect for each choice behavior patterns (data of "Immediate type" was excluded because only one participant was assigned). For the preference-decision group, a two-way ANOVA with the factors behavior pattern (Immediate vs. Indecision) and choice (chosen vs. non-chosen) on the first smell duration revealed a significant interaction [F (1, 20) = 5.27, P < .05]. Compared to the "Indecision" participants, participants assigned to "Narrowing-down type" smelled the chosen odor longer [Narrowing-down .41, Indecision -.38; F (1, 20) = 5.26, P < .05] and smelled the non-chosen odors shorter [Narrowing-down -.08, Indecision .08; F (1, 20) = 5.32, P < .05].

“Narrowing-down type” participants were able to distinguish the odors into like stimuli and dislike stimuli after the first exposure, which may have caused the tendency of the smell bias effect.

For post-choice pleasantness rating, a two-way ANOVA with the factors decision group (preference vs. intensity) and choice (chosen vs. non-chosen) revealed a significant interaction [F (1, 41) = 38.71, P < .01]. The chosen odor (M = 5.97) was rated more pleasant than the non-chosen odors (M = 4.25) in the preference group [F (1, 41) = 35.60, P < .01], on the other hand, the chosen odor (M = 3.60) was rated more unpleasant than the non-chosen odors (M = 4.42) in the intensity decision group [F (1, 41) = 8.02, P < .01]. This result might have been caused by a positive correlation between perceived intensity and hedonic strength in olfaction (Distel et al. 1999; Distel and Hudson 2001).

Experiment 3

In this experiment, we confirmed the influence of alternative discriminability using six odors chosen from a single subcategory of flavored tea category (the different brand of jasmine tea leaves) as alternatives. Moreover, we investigated the influence of category-name on odor choice behavior by comparing between the information group, in which participants were provided the name of alternative category beforehand, and the non-information group, in which participants were not provided such information.

Methods

Participants

Twenty female undergraduate and graduate students from University of Tsukuba (mean age 19.7 years) participated. None of the participants recruited for this experiment had participated in Experiment 1 or 2. Although no sex differences in smell duration time or the smell bias effect were found in Experiment 1 and 2, we decided to only recruit female participants in Experiment 3, because of the possibility that males might not be able to distinguish between similar flavors of jasmine tea as well as females. All participants were healthy with no self-reported problems in their sense of smell. Participants were randomly assigned to either the information group or the non-information group.

Stimuli

Alternatives were chosen from a single subcategory of flavored tea. Six sets of jasmine tea leaves selected from different brands were used (Table 1). These were the same category odors but had different features from each other. In a pilot study, seven female undergraduate students (mean age 21.0 years) who did not participate in the main experiment rated the intensity (0: unscented to 6: strong) and pleasantness (1: very unpleasant to 7: very pleasant) of each six odors on a VAS. Means of intensity was 3.58 (*SD* = 1.17), and pleasantness was 4.35 (*SD* = 1.57). There were no significant differences among odors in both intensity and pleasantness (*Fs* < 1).

Procedure

In the non-information group, the procedure was the same as in Experiment 1. In the information group, participants were told that alternatives were sets of jasmine tea leaves before the preference decision task began. After the decision, participants rated the pleasantness of each of six odors on the VAS from 1 (very unpleasant) to 7 (very pleasant).

Results and Discussion

Mean decision times were 2 m 41 s (range: 1 m 19s to 5 m 6 s) and 3 m 2 s (range: 1 m 21 s to 6 m 5 s) in the non-information and information group respectively (Table 2). Participants in the information group spent more time for decision making than in the non-information group, although there was no significant difference [t (18) = -.50, p = .63; Cohen's d = 0.22] between groups. Participants in the information group were provided the name of the alternative category (“jasmine tea leaves”) beforehand, and thus may have tried harder to perceive the qualitative features of each odor. Therefore, it was difficult for participants of this group to discriminate from each other, and they have to spend more time to make a decision than the non-information group. Furthermore, the mean preference decision times by odor sample were compared across three experiments to examine whether decision making was increasingly difficult from the Experiment 1 to 3. Results showed a significant main effect [F (2, 74) = 5.51, $p < .01$], with the decision time in Experiment 3 (28.5s/odor) significantly longer than that in Experiment 1 (18.1s/odor; Holm multiple comparison test, $p < .05$). These results show that preference decision making was indeed more difficult from Experiment 1 to 3.

For the first and total smell duration time in Experiment 3, a significant smell bias toward the chosen odor was absent for both the information and non-information groups, $Fs < 1$ (Fig. 1). In this experiment, two kinds of choice behavior patterns, "Indecision type" and "Narrowing-down type" were observed (Table 2) and neither of the behavior patterns shows the smell bias effect.

For post-choice pleasantness rating, analysis revealed a marginally significant interaction [F (1, 18) = 3.53, $P < .10$]. The chosen odor (M = 5.36) was rated more pleasant than the non-chosen odors (M = 4.76) in the non-information group [F (1, 18) = 5.36, $P < .05$]. However, the difference between the chosen odor (M = 4.62) and the non-chosen odors (M =

4.71) was non-significant for the information group ($F < 1$). This result also reflected the reduction of discriminability of the alternatives in the information group.

General Discussion

The present study investigated whether smell behavior reflects participants' preference in m-AFC task. To investigate the relationship between the orienting behavior and preference decision (Glaholt and Reingold 2009; Schotter et al. 2010; Shimojo et al. 2003), we analyzed smell duration time at first exposure as well as in total for the chosen odor and the non-chosen odors. The present study showed that the smell bias effect – longer smelling durations for the chosen odor relative to the non-chosen odors – occurs on the first exposure when alternatives are from of multiple categories (Experiment 1), but when alternatives are from a single category (flavored tea, Experiment 2) or from a single subcategory (jasmine tea, Experiment 3). The results found in Experiment 1 corroborated with the findings in vision research which demonstrated that the dwell bias effect occurs due to selective encoding of the stimulus most relevant for the goal of the task, during the first time each stimuli is gazed upon (Glaholt and Reingold 2009; Schotter et al. 2010). In Experiment 1, participants may have been able to discriminate the qualitative features of alternatives more easily than in Experiment 2 and 3.

Particularly, for the information group in Experiment 3, the label for the category

(Jasmine tea) made discriminability between alternatives lower. This was likely due to the information of alternatives facilitating top-down processing and therefore it might disturb the discrimination of each alternative. The result showing no significant difference of pleasantness rating between the chosen odor and the non-chosen odors in the information group is also in support of this interpretation. These findings suggest that the discriminability of alternatives may be a factor for the occurrence of the smell bias effect.

Results concerning observed three choice-behavior patterns (“Immediate type”, “Narrowing-down type” and “Indecision type”) also support the above-mentioned interpretation. Preference decision-making appeared to become more and more difficult from Experiment 1 to 3; mean decision times by odor sample became more longer from Experiment 1 to 3, and the number of participants assigned to “Indecision” type increased as the similarity across alternatives increased (albeit a significant difference across experiments was not found; Fisher's exact test $P = .27$). Moreover, in Experiment 2, “Narrowing-down type” participants might have been able to distinguish the odors into like and dislike stimuli after the first exposure for each odor, resulting in a tendency towards smell bias at the first exposure. While there is a possibility that participants assigned to the “Immediate type” were also able to discriminate between alternatives clearly, they did not show the smell bias effect. However, many of the participants assigned to the “Immediate type” were male across three experiments. Past literature on sex differences in olfaction have shown that females show superior olfactory memory (Dempsey et al. 2002) and superior odor identification (Doty et al. 1984) compared to males and also pay more attention to odors (Havlicek et al., 2008; Herz and Cahill 1997). It can be reasoned that females have generally more interest or experience in choosing odors compared to males, and thus the majority of our “Immediate type” participants may not have been able to discriminate the items of their liking as well as females. This may have resulted in the lack of a smell bias for the “Immediate type” group.

Post-choice pleasantness for the chosen odor was always higher than that of the non-chosen odors except in the case where alternatives were similar each other and the information of the category of alternatives was provided in the information group (Experiment 3). Although previous studies revealed that deliberation interferes with consistency of preference (Nordgren and Dijksterhuis 2009), the present study did not show any differences in post-choice pleasantness among three choice-behavior patterns. Participants rated the pleasantness of odors immediately after making their choices, so there is possibility that they remembered which odor they chose and thus changed their own attitude to fit the choice result. In addition, we classified choice behavior patterns based on the observed behaviors and did not investigate a between-participants design. Previous studies suggest a possible relationship between indecisiveness and personality traits, especially neuroticism (Germeijs and Verschueren

2011), and other studies have also suggested that olfactory sensitivity is positively correlated with either neuroticism or anxiety (Croy et al., 2011; Havlicek et al., 2012; Pause et al., 1998). Therefore, personality traits may have also influenced the results of the current study.

Shimojo et al. (2003) revealed that people, without conscious awareness, tend to prefer stimuli that were presented for a longer time (i.e., looked at longer) than other stimuli, and suggesting that implicit processes may be involved in the relationship between gaze behavior and preference. Olfaction studies (Coppin et al. 2010, 2012) have also reported that participants overestimate the pleasantness for chosen odor and underestimate non-chosen odor at the rating after making choices even when participants forgot their explicit choices. This finding suggests that implicit processes are related to the formation of odor preference. To reveal whether the smell bias effect occur implicitly, it is required to examine whether participants choose the odor presented longer without awareness.

The results of this study did not show a clear smell bias toward the chosen stimulus in preference decision. We suggest that perception of alternatives and the characteristics of choice behavior in olfaction might be modulated by the discriminability of the alternatives. However, for the pleasantness of the odor samples used in Experiment 2, although there were no significant differences among odors as a result of a post-hoc test, the main effect was significant. Hence, it cannot be denied that the possibility of influence from original pleasantness of odors on the smell duration time, so intensity or hedonics of samples should be controlled as much as possible in future studies. In olfactory perception, evaluation of stimuli can only be carried out sequentially because, unlike in vision, stimuli can only be perceived once at a time. Many studies have revealed contextual effects, such as hedonic contrast or assimilation, in which the rating for the current stimuli is influenced by the pleasantness of the preceding stimuli in a sequential rating paradigm using colors (Harris 1929) or pictures or flavors (Zellner et al. 2003). Moreover, repeated exposure to several odors might cause adaptation or olfactory fatigue. Thus, because of the perceptual properties of olfaction, the results of the present study cannot simply be compared to the findings from visual studies. In future research, investigation of contextual effects on pleasantness ratings or choice making focusing on the perceptual properties of olfaction is needed in order to reveal the factors on pleasantness perception of odors.

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Table 1 Odor stimuli used in each of experiment and selectivity (%) of each odor. Selectivity of the intensity group (Experiment 2) and the information group (Experiment 3) are given in parenthesis

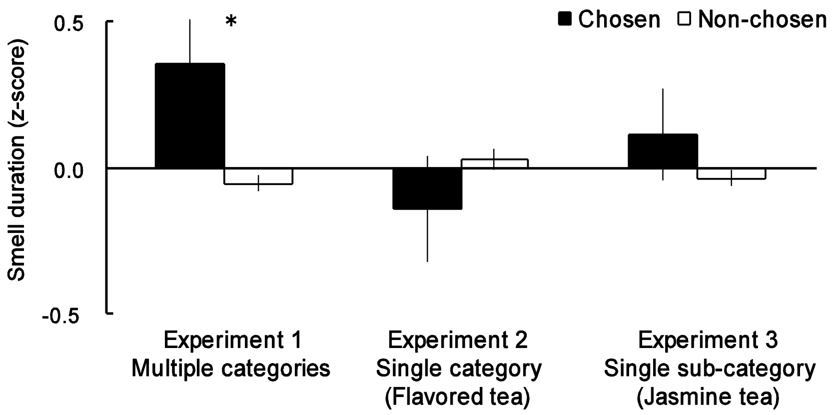
Experiment	Category	Odorants	Selectivity (%)	Quantity (g)
Experiment 1 Preference (n=34)	Multiple categories	**laundry detergent** (liquid type: P & G Japan)	29	7.0
		bar soap (sliced: Cow brand soap KYOSHINSHA Co., Ltd.)	0	6.0
		apple (liquid air freshener: S. T. Corporation)	26	3.5
		fragrant olive (solid air freshener: KOBAYASHI Pharmaceutical Co., Ltd.)	0	0.2
		grapefruit (essential oil: TREE OF LIFE Co., Ltd.)	9	0.1
		peppermint (essential oil: TREE OF LIFE Co., Ltd.)	29	0.1
		Instant coffee (Nestlé Japan)	6	1.0
Experiment 2 Preference(n=23) Intensity(n=20)	Single category (Flavored tea: All product's brand were LUPICIA Co., Ltd.)	**apple**	22 (5)	7
		peach	9 (5)	10
		jasmine	57 (5)	10
		vanilla	0 (55)	13
		chamomile	4 (20)	8
		chamomile & orange	9 (10)	10 (3:7)
Experiment 3 No-Information (n=10) Information (n=10)	Single subcategory (Jasmine tea: Six kinds of jasmine tea leaves selected from different brands)	**A** (Hanamizuki Corporation)	70 (0)	10
		B (Ryohin Keikaku Co., Ltd.)	0 (10)	10
		C (MIKUNIYA Co., Ltd.)	10 (40)	10
		D (LUPICIA Co., Ltd.)	10 (10)	10
		E (LUPICIA Co., Ltd.)	0 (10)	7
		F (ITO EN Ltd.)	10 (30)	10

In Experiment 1, about apple, grapefruit, and peppermint, each of these was soaked into cotton swab, and instant coffee was dissolved into hot water. In Experiment 2 and 3, the tea leaves were presented using tea bags.

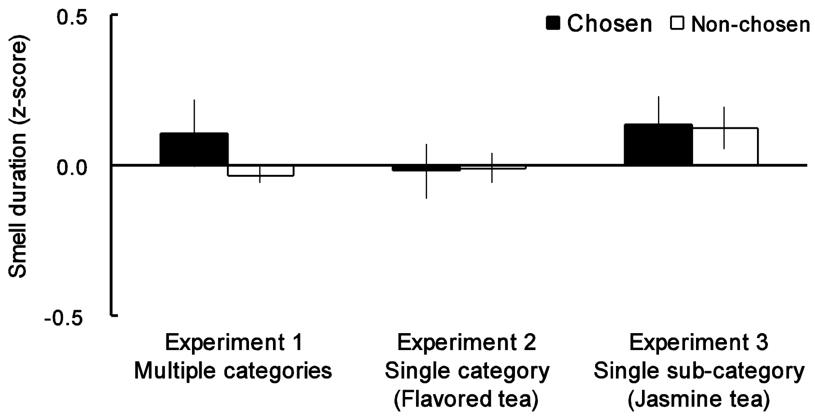
Table 2 Mean decision time and the percentage of participants in the three choice behavior patterns throughout the study

		Experiment 1	Experiment 2		Experiment 3	
		Preference	Preference	Intensity	No-Information	Information
		n=34	n=23	n=20	n=10	n=10
Category		Multiple categories	Single category (Flavored tea)		Single subcategory (Jasmine tea)	
Mean decision time		2m07s	2m47s	2m20s	3m02s	2m41s
Pattern of choice behavior (%)	**Immediate**	18	4	0	0	0
	Narrowing-down	29	35	30	30	30
	Indecision	53	61	70	70	70

Not surprisingly, the number of pre-decision exposure with the chosen odor was larger than that with non-chosen odors in all experiments ($P < .01$)



(a) First smell duration



(b) Total smell duration

Fig. 1 Standardized smell duration for the first and total smell for the chosen odor and non-chosen odors in each experiment. Error bar shows the standard errors of the means. In Experiment 3, because there was no significant effect of smell duration between groups, standardized mean smell durations were collapsed across the information group and the non-information group. * $P < .05$.

Erratum to: Smell Behavior During Odor Preference Decision

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The selectivity and quantity for the experiment 1 in Table 1 were printed mistakenly. The correct table is reprinted below with their legend.

Table 1 Odor stimuli used in each of experiment and selectivity (in percent) of each odor. Selectivity of the intensity group (experiment 2) and the information group (experiment 3) are given in parenthesis

Experiment	Category	Odorants	Quantity (g)	Selectivity (%)
Experiment 1 Preference (n=34)	Multiple categories	laundry detergent (liquid type: P & G Japan)	7.0	29
		bar soap (sliced: Cow brand soap KYOSHINSHA Co.,Ltd)	6.0	0
		apple (liquid air freshener: S.T.Corporation)	3.5	26
		fragrant olive (solid air freshener: KOBAYASHI Pharmaceutical Co.,Ltd.)	0.2	0
		grapefruit (essential oil: TREE OF LIFE Co.,Ltd.)	0.1	9
		peppermint (essential oil: TREE OF LIFE Co.,Ltd.)	0.1	29
		Instant coffee (Nestlé Japan)	1.0	6
Experiment 2 Preference(n=23) Intensity(n=20)	Single category (Flavored tea: All product's brand were LUPICIA Co., Ltd.)	apple	7	22 (5)
		peach	10	9 (5)
		jasmine	10	57 (5)
		vanilla	13	0 (55)
		chamomile	8	4 (20)
		chamomile & orange	10 (3:7)	9 (10)
Experiment 3 No-Information (n=10) Information (n=10)	Single subcategory (Jasmine tea: Six kinds of jasmine tea leaves selected from different brands)	A (Hanamizuki Corporation)	10	70 (0)
		B (Ryohin Keikaku Co., Ltd.)	10	0 (10)
		C (MIKUNIYA Co., Ltd.)	10	10 (40)
		D (LUPICIA Co., Ltd.)	10	10 (10)
		E (LUPICIA Co., Ltd.)	7	0 (10)
		F (ITO EN Ltd.)	10	10 (30)